

# Container Ships Safety

Jaime Rodrigo de Larrucea. Prof. Maritime Law (UPC)

## **Abstract:**

The purpose of this article is to give a general overview of the most important legal aspects of the maritime safety in relation with the container ships including the equipment and operational aspects.

## **1. - Introduction**




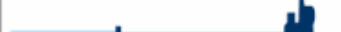


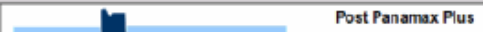
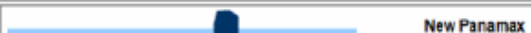
*Malcolm McLean* was a modest road haulage operator. One day, while he was unloading some packages from his vehicle and placing them one by one inside the ship in the port, he wondered whether it would not be possible to raise the chassis of the truck and put it on the vessel along with all the goods. It seemed a fairly logical solution, as loading the packages or boxes one by one was an extremely fatiguing job as well as a sheer waste of time. So *McLean's* basic idea was to fill a ship with these containers at the port of destination and load others.

*McLean* took his idea to a group of friends, among them, the engineer *Charles Tushing*. The latter added a few technical details to *McLean's* basic idea, for instance, how to lift the containers and deposit them on the vessels. In the words of the chairman of the History of Containerisation Foundation, "*this is still the basic system that is used today*".<sup>1</sup>

The first container ship was the *Ideal-X* which set sail from the port of *Newark* on 26 April, 1956 with 58 containers with a height of 20 feet. The vessel took six days to reach *Houston*. The idea was an immediate success, and the only thing left to do was to create a feasible system to perform the whole process efficiently and rapidly. Indeed, it was so successful that the company *Dupont* filled the vessel with containers for the return trip to *Newark*.

---

<sup>1</sup> See general and economic aspects: Brian J. Cudahy (April 2006). *Box Boats*. Fordham University Press. ISBN 0-8232-2568-2. <http://fordhampress.com/detail.html?isbn=9780823225682>. – *How Container Ships Changed the World*. Frank Broeze (2002). *The Globalisation of the Oceans*. International Maritime Economic History Association. ISBN 0-9730073-3-8. – *Containerisation from the 1950s to the Present*. Marc Levinson (2006). *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger*. Princeton University Press. ISBN 0-691-12324-1.

		Length	Draft	TEU
First (1956-1970)	 Converted Cargo Vessel	135 m	< 9 m	500
	 Converted Tanker	200 m	< 30 ft	800
Second (1970-1980)	 Cellular Containership	215 m	10 m 33 ft	1,000 – 2,500
Third (1980-1988)	 Panamax Class	250 m	11-12 m	3,000
	 Panamax Class	290 m	36-40 ft	4,000
Fourth (1988-2000)	 Post Panamax	275 – 305 m	11-13 m 36-43 ft	4,000 – 5,000
Fifth (2000-2005)	 Post Panamax Plus	335 m	13-14 m 43-46 ft	5,000 – 8,000
Sixth (2006-)	 New Panamax	397 m	15.5 m 50 ft	11,000 – 14,500

The evolution in container ships construction

The need to speed up the container loading and unloading process quickly led to a new business; that of container ship cranes. A completely new, different business was invented, if we consider the size of one of those cranes. Thanks to that first bold adventure of the *Ideal-X*, *Malcolm McLean* set up the company *SeaLand Service* which has become a name of reference in the transportation industry. That company is now owned by *Maersk* (*Maersk Sea Land*).

The limitations in the size of these ships are due to the strategic geographic crossings through which they have to pass:

- *Panamax*: 5000 TEU total length 320 m., beam 33.5 m., draft 12.5 m. 12000 TEU (following the latest extension of the canal which is scheduled to end in 2014).
- *Suezmax*: 14000 TEU Displacement of 137,000 DWT, total length 400 m., beam 50 m., approximate draft 15 m.
- *Malacamax*: 18000 TEU Displacement of 300,000 DWT, total length 470 m, beam 60 m, draft approximately 16 m. (theoretic calculation).

The container itself is based on an extremely logical and efficient idea: a large metal case in which goods are stowed one by one and then transported using protective methods. This idea completely rules out traffic and the general philosophy of goods transportation that had been used until then, and gave rise to an evolution in the design of the usual 3-tower general cargo ships to the modern container ships with multiple holds and large decks, to the point of reaching the extreme of the “*Open-Top*” ships.

It is not strictly true to say that these ships are the most specific ones that exist, since although they carry only containers, they vary to such a wide degree that the goods carried have different possibilities with the same morphological structure of the ship. At present, a distinction can be drawn between container ships, depending on their size and transportation capacity (total number of TEUs). The size and transportation capacity is what makes them "suitable" for some routes or others.

Container ships are classified based on their routes, into the following types:

*Transatlantic liners*: these are the largest, and may reach up to 14500 TEU. The number of stops must be kept to a minimum for them to be profitable to operate, with 2 or 3 stops per trip. Approximately 50-60% of their total cargo must be unloaded for a stop to be profitable.



The *Emma Maersk* is a perfect example of a transatlantic liner with a capacity of 11,000 TEUs.<sup>2</sup> - *Ocean liners* cover medium and long-distance routes without making round trips. Container ships with capacities between 4,000 and 8,000 TEUs are ideal for this type of route. This type of ship is often used in transatlantic routes.

---

<sup>2</sup> "In common calculation, her cargo capacity is much bigger - between 13,500 and 14,500 TEU. The difference between the official and estimated number results from the fact that Maersk calculates the cargo capacity of a container ship by using the number of containers with a weight of 14 tons that can be carried on a vessel. For the *Emma Maersk*, this is 11,000 containers. Other companies calculate the cargo capacity of a ship according to the maximum number of containers that can be put on the ship, independent of the weight of the containers. This number is always greater than the number calculated by the Maersk company." Information available at <[www.emma-maersk.com/specification](http://www.emma-maersk.com/specification)>



The *ZIM Virginia* (5,000 TEUs) is an excellent example of an ocean liner.



The ship *Euphoria* is a good example of a *feeder* ship.

- *Feeder ship*: True to its name, this type of ship actually “feeds” the Hub ports in which transatlantic and ocean liners stop. Only the smallest ships can connect large Hub ports with smaller ports where transatlantic liners are unable to stop due to their size. For this reason these ships exist, which range from several hundred TEUs to 3,000/4,000 TEUs.

Top 10 container shipping companies in order of TEU capacity, 17 August 2009

Company	TEU capacity	Number of ships
<b>A.P. Moller-Maersk Group</b>	2,022,956	539
<b>Mediterranean Shipping Company S.A.</b>	1,517,200	409
<b>CMA CGM</b>	1,023,208	365
<b>Evergreen Marine Corporation</b>	594,154	162
<b>American President Lines</b>	531,865	135
<b>Hapag-Lloyd</b>	475,282	120
<b>COSCO</b>	469,848	146
<b>China Shipping Container Lines</b>	449,469	139
<b>NYK Line</b>	412,711	109
<b>Hanjin Shipping</b>	406,462	90

(Source: AXS-Alphaliner Top 100: Operated fleets as per 12 May 2009. May 2009.)

## 2.- Applicable Conventions and Codes

### 2.1.- Basic agreements and agreements with a general scope

#### 2.1.1. SOLAS:

For the purposes of all Safety Codes and Standards, container ships are considered to be Standard cargo ships with no particularities that require specific regulation, and only certain rules of interpretation exist, attached to already-existing codes (e.g., Resolution MSC/Circ.608 on the method used to calculate the admeasurement of vessels).

In the section on Damage Stability, SOLAS indicates that open-top ships have the regulations applicable to them as a general ship with hatch covers. Another aspect to be highlighted regarding Open-top ships is that their holds are not hermetically sealed, which means that automatic fire-fighting systems (CO<sub>2</sub>) cannot be used. This makes it necessary to use alternative systems such as sprinklers and other important systems to contain the fire, as there are no bulkheads to separate the holds.

#### **Intact stability:**

The analysis to be performed on applying safety guidelines relating to stability for container ships must be based on the specific IMO guideline in this respect, in which the *“Code on intact stability for all types of ships covered by IMO instrument”* is the basic guideline, approved by resolution A.749 (18) of that institution. This Code was officially translated into Spanish as *“Código de estabilidad sin avería para todos los buques recogidos por los instrumentos de la OMI”*.

The purpose of this code is to recommend the stability criteria and other measures to guarantee the operational safety of all ships, with a view to reducing risks for the ships themselves, the staff on board them and the environment.

The intact stability criteria for container ships are defined as follows:

- The area below the curve of righting arms (curve of GZ arms) will not be less than 0.009/C m.rad up to a list angle  $\theta = 30^\circ$  or less than 0.016/C m.rad up to a list angle  $\theta = 40^\circ$ , or up to the flooding angle  $\theta_f$  if it is less than  $40^\circ$ .
- The area below the curve of righting arms (curve of GZ) between list angles of  $30^\circ$  and  $40^\circ$  or between  $30^\circ$  and  $\theta_f$ , if that angle is less than  $40^\circ$ , will not be less than 0.006/C m.rad.
- Righting arm GZ will be at least 0.033/C m at a list angle equal to or greater than  $30^\circ$ .

- The maximum righting arm will be at least 0.042/C m.
- The total area below the curve of righting arms (curve of GZ arms) to the flooding angle  $\phi_f$  will not be less than 0.029/C m.rad.
- With respect to the above criteria, the factor of shape C will be calculated using the following formula and figure 1:

$$C = \frac{d \cdot D'}{B_m^2} \sqrt{\frac{d}{KG}} \left( \frac{C_B}{C_W} \right)^2 \sqrt{\frac{100}{L}}$$

where: d = Average draft, in metres.

$$D' = D + h \times \frac{2b - B_D}{B_D} \times \frac{2 \sum l_H}{L}, \quad \text{as defined in figure 1}$$

D = Molded draft of the ship in metres;

B = Molded beam of the ship, in metres;

KG = height of the centre of gravity on the keel, in metres; a KG height value of less than d will not be used;

$C_B$  = Block coefficient;

$C_W$  = Flotation FLAT coefficient.

Furthermore, the Code recommends the use of electronic loading and stability computers to determine the seating and stability of the ship under different operating conditions.

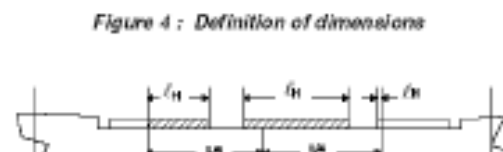
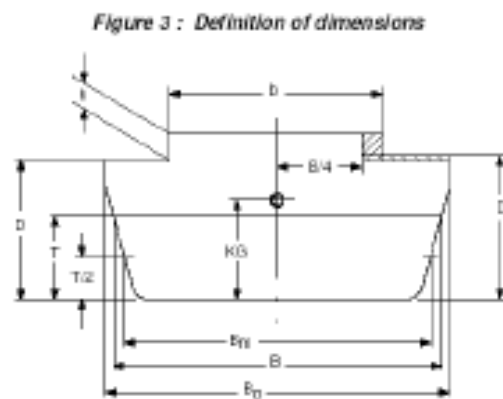
With respect to Open-Top ships, they must stay afloat during any situation of flooding of the hold (maintaining relative positive stability in the case of flooding at 100%), and a maximum reduction in the phenomenon of free water surface on board.

The IMO regulations require the ratio of the water on board to be no more than the open surface by 400mm/hour in tests performed with experimental canals. There is also strict regulation with respect to the machinery that must evacuate the water on board.

As regards definitions, the code is governed by those used by it and if they are not included in the code, the definitions used in the SOLAS 1974 Agreement apply. I shall use the following definitions, since they are the object of the present study:

- Container ship: a ship that is dedicated mainly to transporting maritime containers.
- Freeboard: the distance between the assigned load line and the freeboard deck.

For the purpose of applying chapters I and II of the 1966 Load Lines Agreement, Annexe I for container ships without hatch covers, the “*freeboard deck*” is the one stipulated in the 1966 Load Lines Agreement (*Load Line 1966*), assuming that the load hatch coaming has hatch covers installed.



**Figure showing the dimensions and parameters of container ships.**

We should consider that the code to which this rule applies specifically enumerates this guideline for ship containers, without referring to any particular class of ship but to all of them, and gives the general guidelines for safe stability and the regulations that must be complied with in relation to the general description of the ship that must be included in the stability log and the FLATs of the general provision for the ship, which must include the watertight compartments, closing devices, air vents, descending flooding angle, permanent ballast, permitted deck load and freeboard diagrams.

It also specifies the obligation of all ships to have the curves or hydrostatic tables and cross stability curves, calculated with free seating for the foreseen range of displacements and seating in service, under normal operating conditions. They must have the FLAT or capacities tables in which the capacity and centre of gravity of each of the load spaces are shown.



### 2.1.2. Convention for Safe Containers (CSC):

The Convention was signed in 1972 and took effect in 1977. It was drawn up within the framework of a joint Conference between the IMO and the UN. The convention has two clearly differentiated objectives:

- Safety in handling containers:

Maintenance of high levels of safety in transportation and handling, giving the requirements for resistances, control and test. In the test section, a container that is to be approved with the seal of the Classification Company (*Class*) *Germanischer Lloyd* must obtain values that are 1.5 times the values stipulated by the CSC.

- The promoting of international container transportation:

This contains the standardisation and documentary provisions of the containers in all the countries signing the convention, with a view to ensuring the container is transported with the minimum amount of paperwork.

This Convention will apply to all containers having corner bands and a series of minimum measurements with the exception of those dedicated solely to air transportation. For a container to be used, it must pass an inspection by the country signing the CSC. I should just comment that certain companies qualified to perform these inspections usually demand higher standards. The highest are those requested by *Germanischer Lloyd*.

The Government or its authorised representative authorises the manufacturer to affix a plate on the approved containers, guaranteeing their safety, which contains the respective information.

Approval and the awarding of the safety plate granted by a Contractual State must be acknowledged by the other Contractual States. This principle of mutual acceptance of approved containers is the key element in the Convention; once approved, and through the respective plate, it is expected that the container can circulate in international transport with a minimum of paperwork for safety control purposes. The subsequent maintenance of an approved container is the responsibility of the owner, who is also responsible for guaranteeing that the container is regularly reviewed.



CSC safety approval plate.

The technical annexe of the Convention specifically requires the container to be subjected to different tests representing a combination of safety requirements for both land and maritime transportation.

## 2.2.- International regulations, specific or occasional agreements

### 2.2.1. IMO Regulations:

*Resolution A.708 (17), Visibility from the bridge.*

In response to the problems posed by the typical morphology of container ships, through this Resolution, approved on 6 November 1991, the IMO implemented a guide for standardising the minimum visibility conditions from the bridge, which in many cases is quite restricted, due to the height of the decks. We need not mention the capital importance of correct visibility from the bridge in guaranteeing the safety of the ship:

## 2. Application:

The guide applies to vessels built after 2 January 1992 in which the ship's crew is constantly on duty on the bridge. Ship-builders and designers are urged to use this guide in designing their ships.

In the case of specially-designed ships that cannot comply with the requirements set forth in this guide, provisions will be considered to provide a level of visibility that is as close as possible to the one established by the guide.

## 3. Field of vision:

The sight of the sea surface from the bridge must not be hidden by more than two ship lengths or 500 m, whichever is the smaller, on the bow of the ship and  $10^\circ$  at each side, irrespective of the draft, ship trim and load on the deck.

The blind spots due to the cargo, loading/unloading elements and other obstructions must not prevent a clear view from the bridge through an arc of more than  $10^\circ$  for each. The total blind area must not exceed  $20^\circ$ . The visible sectors between each blind spot must be no more than  $5^\circ$ .

The horizontal field of vision from the ship's bridge must extend over an arc of more than  $22.5^\circ$  to the stern at both sides of the ship.

From each side of the bridge, the field of vision must extend over an arc of at least  $45^\circ$  from the opposite bow timbers to the bow and from the bow to the stern over an arc of  $180^\circ$  towards the stern.

From the main command post, the field of vision must extend  $60^\circ$  at each side. The ship's side must be visible from the wing.

## 4. Windows:

The structure between the bridge windows must be as small as possible and not installed immediately in front of any work station.

To prevent glare, the bridge windows will be inclined with respect to the upper FLAT at an angle of no less than  $10^\circ$  and no more than  $25^\circ$ .

There will have a clear view from at least two bridge windows. Depending on the configuration of the bridge, there may be more windows with a clear view, regardless of the weather conditions.

### 2.2.2. IMDG Code:

The IMDG Code proposes a more specific treatment for container ships when they carry containers commonly known as “*IMO containers*”, which are containers carrying some types of dangerous goods that must be segregated to prevent risks due to incompatibility between cargoes.

Paragraph 1.2.1. of the IMDG Code contains the following definition:

*“Cell ship: a ship in which the containers are loaded below deck, inside specially-designed pits in which the containers are permanently stowed during their transportation by sea. The containers that are loaded on deck in these ships are stacked and held in place by special devices.*

*Container: a permanent transportation equipment element that is strong enough to be used several times, that is specially designed for the transportation of goods using one or several modes of transport without the intermediate handling of the cargo and in such a manner that it can be easily secured and/or. For this purpose it is fitted with the appropriate accessories and approved in accordance with the revised terms of the International convention on safety of containers (CSC), 1972. The term "container" does not include vehicles, packaging or wrapping. However, it does include containers transported on chassis.*

*With respect to containers for the transportation of radioactive material, see 2.7.2.”*

In addition the IMDG Code uses a series of graphs and charts to establish the rules for segregating “*IMO containers*”, in all cases making a distinction with conventional container ships (with holds and decks) and open-top ships (with no hold to speak of but just one deck that starts on the FLAT of the ship’s hold (which, for the purpose of ensuring better compliance with the IMDG Code are now being designed with one or two holds on the ship’s bow). It also mentions the transportation of containers in RoRo ships, but this subject lies outside the scope of this article.

Below are two segregation charts established by the IMDG for container ships:

- Segregation chart for containers on board container ships.
- Segregation chart for transportation units on board container ships without hatch covers.

SEGREGATION REQUERIMENT	VERTICAL			HORIZONTAL						
	CLOSED VERSUS OPEN	CLOSED VERSUS OPEN	OPEN VERSUS OPEN		CLOSED VERSUS CLOSED		CLOSED VERSUS OPEN		OPEN VERSUS OPEN	
					ON DECK	UNDER DECK	ON DECK	UNDER DECK	ON DECK	UNDER DECK
“AWAY FROM” -1	“ONE ON TOP OF THE OTHER PERMITTED”	OPEN ON TOP OF CLOSED PERMITTED	NOT IN THE SAME VERTICAL LINE UNLESS SEGREGATED BY A DECK	FORE AND AFT	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	ONE CONTAINER SPACE	ONE CONTAINER SPACE OR ONE BULKHEAD
		ATHWART-SHIPS		NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	ONE CONTAINER SPACE	ONE CONTAINER SPACE	
“SEPARATED FROM” -2	NOT IN THE SAME VERTICAL LINE UNLESS SEGREGATED BY A DECK	AS FOR OPEN VERSUS OPEN		FORE AND AFT	ONE CONTAINER SPACE	ONE CONTAINER SPACE OR ONE BULKHEAD	ONE CONTAINER SPACE	ONE CONTAINER SPACE OR ONE BULKHEAD	ONE CONTAINER SPACE	ONE BULKHEAD
				ATHWART-SHIPS	ONE CONTAINER SPACE	ONE CONTAINER SPACE	ONE CONTAINER SPACE	TWO CONTAINER SPACES	TWO CONTAINER SPACES	ONE BULKHEAD
				FORE AND AFT	ONE CONTAINER SPACE	ONE BULKHEAD	ONE CONTAINER SPACE	ONE BULKHEAD	TWO CONTAINER SPACES	TWO BULKHEADS
ATHWART-SHIPS			TWO CONTAINER SPACES	ONE BULKHEAD	TWO CONTAINER SPACES	ONE BULKHEAD	THREE CONTAINER SPACES	TWO BULKHEADS		
“SEPARATED BY A COMPLETE COMPARTMENT OR HOLD FROM” -3										
“SEPARATED LONGITUDINALLY BY AN INTERVENING COMPLETE COMPARTMENT OR HOLD FROM” -4	PROHIBITED			FORE AND AFT	MINIMUM HORIZONTAL DISTANCE OF 24 M*	ONE BULKHEAD AND MINIMUM HORIZONTAL DISTANCE OF 24 M*	MINIMUM HORIZONTAL DISTANCE OF 24 M*	TWO BULKHEADS	MINIMUM HORIZONTAL DISTANCE OF 24 M*	TWO BULKHEADS
				ATHWART-SHIPS	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED

Segregation chart for containers on board container ships.<sup>3</sup>

\* Containers not less than 6 m from intervening bulkhead

Note: All bulkheads and decks should be resistant to fire and liquid.

<sup>3</sup> See IMO. *IMDG Code: International Maritime Dangerous Goods Code*. Volume 1. 2006 Version.

SEGREGATION REQUERIMENT	VERTICAL			HORIZONTAL							
	CLOSED VERSUS OPEN	CLOSED VERSUS OPEN	OPEN VERSUS OPEN		CLOSED VERSUS CLOSED		CLOSED VERSUS OPEN		OPEN VERSUS OPEN		
					ON DECK	UNDER DECK	ON DECK	UNDER DECK	ON DECK	UNDER DECK	
“AWAY FROM” -1	“ONE ON TOP OF THE OTHER PERMITTED”	OPEN ON TOP OF CLOSED PERMITTED	NOT IN THE SAME VERTICAL LINE UNLESS SEGREGATED BY A DECK	FORE AND AFT	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	ONE CONTAINER SPACE	ONE CONTAINER SPACE OR ONE BULKHEAD	
		ATHWART-SHIPS		NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	ONE CONTAINER SPACE	ONE CONTAINER SPACE		
“SEPARATED FROM” -2	NOT IN THE SAME VERTICAL LINE UNLESS SEGREGATED BY A DECK	AS FOR OPEN VERSUS OPEN		FORE AND AFT	ONE CONTAINER SPACE	ONE CONTAINER SPACE OR ONE BULKHEAD	ONE CONTAINER SPACE	ONE CONTAINER SPACE OR ONE BULKHEAD	ONE CONTAINER SPACE AND NOT ABOVE SAME HOLD	ONE BULKHEAD	
				ATHWART-SHIPS	ONE CONTAINER SPACE	ONE CONTAINER SPACE	TWO CONTAINER SPACES	TWO CONTAINER SPACES	TWO CONTAINER SPACES AND NOT ABOVE SAME HOLD	ONE BULKHEAD	
“SEPARATED BY A COMPLETE COMPARTMENT OR HOLD FROM” -3				FORE AND AFT	ONE CONTAINER SPACE AND NOT ABOVE SAME HOLD	ONE BULKHEAD	ONE CONTAINER SPACE AND NOT ABOVE SAME HOLD	ONE BULKHEAD	TWO CONTAINER SPACES AND NOT ABOVE SAME HOLD	TWO BULKHEADS	
				ATHWART-SHIPS	TWO CONTAINER SPACES AND NOT ABOVE SAME HOLD	ONE BULKHEAD	TWO CONTAINER SPACES AND NOT ABOVE SAME HOLD	ONE BULKHEAD	THREE CONTAINER SPACES AND NOT ABOVE SAME HOLD	TWO BULKHEADS	
“SEPARATED LONGITUDINALLY BY AN INTERVENING COMPLETE COMPARTMENT OR HOLD FROM” -4	PROHIBITED			FORE AND AFT	MINIMUM HORIZONTAL DISTANCE OF 24 M* AND NOT ABOVE SAME HOLD	ONE BULKHEAD AND MINIMUM HORIZONTAL DISTANCE OF 24 M*	MINIMUM HORIZONTAL DISTANCE OF 24 M* AND NOT ABOVE SAME HOLD	TWO BULKHEADS	MINIMUM HORIZONTAL DISTANCE OF 24 M* AND NOT ABOVE SAME HOLD	TWO BULKHEADS	
				ATHWART-SHIPS	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	

Segregation chart for transport units on board open-top container ships.<sup>4</sup>

\* Containers not less than 6 m from intervening bulkhead

Note: All bulkheads and decks should be resistant to fire and liquid.

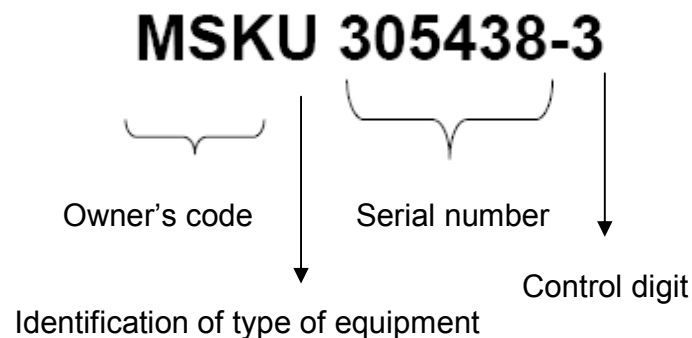
<sup>4</sup> See IMO. IMDG Code: International Maritime Dangerous Goods Code. Volume 1. 2006 Version.

### 2.2.3. ISO 63463 Standard<sup>5</sup>:

The ISO 6346 standard promotes the standardisation of all containers and establishes the TEU (*Twenty feet Equivalent Unit* as the base unit). This standard establishes:

- An identification system for each container through:
  - An owner's code commonly known as the BIC<sup>6</sup> code.
  - A letter identifying the type of equipment.
  - A serial number.
  - A control digit.
- A code establishing the measurements and type of container.
- A country code.
- Operating markings.

**Container identification system:**



**Owner's code:** This is comprised of three block capital letters from the Roman alphabet designating the owner or main operator of the container. This code must be registered in the BIC<sup>4</sup>.

**Type of equipment:** Consisting of one of the following three block capitals from the Roman alphabet:

- U: For common containers.
- J: For attachable auxiliary equipment.
- Z: For road transport chassis or trailers.

---

<sup>5</sup> International Standardisation Organization.

<sup>6</sup> *Bureau International des Containers et du Transport Intermodal*

Serial number: Consisting of 6 numerical digits assigned by the owners or operators that are used by the owner or operator to identify their containers.

Control digit: Consisting of one numerical 1 digit for the purpose of checking the authenticity of the owner code number and serial number. This control digit is of prime importance as it guarantees correct entry in transmissions and in inputting into computer-assisted systems. It is calculated by means of an algorithm.

**Container code (type and measurements):**

	Type of ISO group		Type of ISO measurement
Code	Description	Code	Description
22GP	ALL-PURPOSE CONT.	20G0	ALL-PURPOSE CONT.
		20G1	ALL-PURPOSE CONT.
20HR	INSULATED CONTAINER	20H0	INSULATED CONTAINER
20PF	FLAT (FIXED ENDS)	20P1	FLAT (FIXED ENDS)
20TD	TANK CONTAINER	20T3	TANK CONTAINER
		20T4	TANK CONTAINER
		20T5	TANK CONTAINER
		20T6	TANK CONTAINER
20TG	TANK CONTAINER	20T7	TANK CONTAINER
		20T8	TANK CONTAINER
20TN	TANK CONTAINER	20T0	TANK CONTAINER
		20T1	TANK CONTAINER
		20T2	TANK CONTAINER
22BU	BULK CONTAINER	22B0	BULK CONTAINER
22GP	ALL-PURPOSE CONT.	22G0	ALL-PURPOSE CONT.
		22G1	ALL-PURPOSE CONT.
22HR	INSULATED CONTAINER	22H0	INSULATED CONTAINER
22PC	FLAT (FOLDABLE)	22P3	FLAT (FOLDABLE)
		22P8	FLAT
		22P9	FLAT (FOLDABLE)
22PF	FLAT (FIXED ENDS)	22P1	FLAT (FIXED ENDS)
		22P7	FLAT
22RC	REFRIG. CONTAINER (NOT FOODS)	22R9	REFRIG. CONTAINER (NOT FOODS)
22RS	BUILT-IN GEN. F. POWER SPLY OF REF	22R7	BUILT-IN GEN. F. POWER SPLY OF REF



22RT	REFRIG. CONTAINER	22R1	REFRIG. CONTAINER
22SN	NAMED CARGO CONTAINER	22S1	NAMED CARGO CONTAINER
22TD	TANK CONTAINER	22T3	TANK CONTAINER
		22T4	TANK CONTAINER
		22T5	TANK CONTAINER
		22T6	TANK CONTAINER
22G	TANK CONTAINER	22T7	TANK CONTAINER
		22T8	TANK CONTAINER
22TN	TANK CONTAINER	22T0	TANK CONTAINER
		22T1	TANK CONTAINER
		22T2	TANK CONTAINER
22UP	HARDTOP CONTAINER	22U6	HARDTOP CONTAINER
22UT	OPEN TOP CONTAINER	22UT	OPEN TOP CONTAINER
22VH	VENTILATED CONTAINER	22V0	VENTILATED CONTAINER
		22V2	VENTILATED CONTAINER
		22V3	VENTILATED CONTAINER
25GP	GP CONTAINER OVER-HEIGHT	25G0	GP CONTAINER OVER-HEIGHT
26GP	GP CONTAINER OVER-HEIGHT	26G0	GP CONTAINER OVER-HEIGHT
26HR	INSULATED CONTAINER	26H0	INSULATED CONTAINER
28TG	GAS CONTAINER	28T8	GAS CONTAINER
28UT	OPEN TOP (AVG. HEIGHT)	28U1	OPEN TOP (AVG. HEIGHT)
28VH	VE-AVG. HEIGHT = 1448MM	28V0	VE-AVG. HEIGHT = 1448MM
29PL	PLATFORM	29P0	PLATFORM
2EGP	ALL-PURPOSE WITHOUT VENTILATION, 2.5 IN WIDTH	2EG0	HIGH CUBE CONTAINER (2.5 IN WIDTH)
42GP	ALL-PURPOSE CONTAINER	42G0	ALL-PURP. CONTAINER
		42G1	ALL-PURP. CONTAINER
42HR	INSULATED CONTAINER	42H0	INSULATED CONTAINER
42PC	FLAT (FOLDABLE)	42P3	FLAT (FOLDABLE)
		42P8	FLAT

		42P9	FLAT (FOLDABLE)
42PF	FLAT (FIXED ENDS)	42P1	FLAT (FIXED ENDS)
42PS	FLAT (SPACE SAVER)	42P6	FLAT (SPACE SAVER)
42RC	REFRIG. CONT (NOT FOODS)	42R9	REFRIG. CONT (NOT FOODS)
42RS	REFRIG. CONTAINER (GEN. DIESEL)	42R3	REFRIG. CONTAINER (GEN. DIESEL)
42RT	REFRIG. CONTAINER	42R1	REFRIG. CONTAINER
42SN	NAMED CARGO CONTAINER	42S1	NAMED CARGO CONTAINER
42TD	TANK CONTAINER	42T5	TANK CONTAINER
		42T6	TANK CONTAINER
42TG	TANK CONTAINER	42T8	TANK CONTAINER
42TN	TANK CONTAINER	42T2	TANK CONTAINER
42UP	HARDTOP CONTAINER	42U6	HARDTOP CONTAINER
42UT	OPEN TOP CONTAINER	42U1	OPEN TOP CONTAINER
45BK	BULK CONTAINER	45B3	BULK CONTAINER
45GP	HIGH CUBE CONTAINER	45G0	HIGH CUBE CONTAINER
		45G1	HIGH CUBE CONTAINER
45PC	FLAT (FOLDABLE)	45P3	FLAT (FOLDABLE)
		45P8	FLAT
45RC	REFRIG. CONT. (NOT FOODS)	45R9	REFRIG. CONT. (NOT FOODS)
45RT	REFRIG. CONT.	45R1	REFRIG. CONT.
45UT	OPEN TOP CONTAINER	45U1	OPEN TOP CONTAINER
45UP	HARDTOP HIGH CUBE CONT.	45U6	HARDTOP HIGH CUBE CONT.
46HR	INSULATED CONTAINER	46H0	INSULATED CONTAINER
48TG	GAS TANK	48T8	GAS TANK
49PL	PLATFORM	49P0	PLATFORM
4CGP	GP CONTAINER	4CG0	GP CONTAINER (WIDTH 2.5 M)
L0GP	HIGH CUBE CONTAINER	LOG1	HIGH CUBE CONTAINER
L2GP	HIGH CUBE CONTAINER	L2G1	HIGH CUBE CONTAINER
L5GP	HIGH CUBE CONTAINER	L5G1	HIGH CUBE CONTAINER

### **Country code (optional):**

This consists of two block capital letters from the Roman alphabet described in the ISO 3166<sup>7</sup> standard. They indicate the country where the container is registered but not the nationality of the owner or operator.

### **Operating markings:**

These have the sole mission of providing information that is necessary for handling the containers, in addition to furnishing visual warnings. The most common of these are the following:

- The weight of the containers.
- Electrical risk sign.
- A black and yellow bar sign indicating that the height is greater than that of a standard container (more than 2.6 metres).

Other ISO standards regulating aspects related to containers:

- ISO 668 – Shipping Containers – Classification, dimensions and values
- ISO 830 – Shipping Containers – Terminology
- ISO 1161 – Shipping Containers – Corner specifications
- ISO 1496 – Shipping Containers – Specifications and testing
- ISO 2308 – Hooks for lifting containers with capacities of up to 30mt – Basic requirements
- ISO 3874 – Shipping Containers – Handling and securing
- ISO 8323 – Shipping Containers – All-purpose Air/Surface (intermodal) containers – Testing and specifications
- ISO 9669 – Shipping Containers – Interface connections for tank containers
- ISO 9711 – Shipping Containers – Information related to containers on board ships
- ISO 9897 – *Container equipment data exchange (CEDEX)*
- ISO 10368 – Thermal Shipping Containers – Remote monitoring of conditions
- ISO 10374 – Shipping Containers – Automatic identification

### **2.2.4. Montreal Protocol:**

This protocol, dated 1982, establishes the prohibition and elimination of refrigerated containers using CFC cooling gases.

---

<sup>7</sup> The ISO 3166 or “Code for the representation of names of countries and their subdivisions” establishes the codes for names of countries, dependent territories and special areas of geographic interest and their main sub-divisions.

### 3. - Loading and securing manuals

These are based on the following codes:

- Code of safe practice for cargo stowage and securing in IMO Dec. A. 714 (17)
- Code of safe practice for cargo stowage and securing (CSS)
- SOLAS chapters 6 and 7

The above codes refer to the ship's Cargo Securing Manual, which in practice is usually included in the ISM code. The purpose is to define all relevant aspects of the procedure for loading and securing the cargo and the most appropriate way to achieve this. It is therefore a regulation established by the shipping company itself which, with a technical constructive basis, and the advice of the crew on board (captains and first mates) stipulated how to load and secure the cargo. This varies in ships from the same company, depending on the routes, since it may be considered that the cargo must be secured in a different way on one ship than on another taking a different route.

The Captain is responsible for ensuring that the cargo units are properly and effectively stowed and secured at all times, considering the prevailing conditions and general principles described in the Manual.

The Loading Manual must not only be carried on board ship, but reviewed and updated on a regular basis: if it should be necessary to replace securing elements, this should in all cases be done using others of the same type and quality as those specified in the manual, and for replacement using different elements, the manual must be modified with the approval of the National Shipping Authority.

Experience has shown that lack of expertise in securing the cargo is one of the causes that gives rise to the cargo sliding, in addition to lack of knowledge of the ship's seafaring qualities (especially the moments of rolling and pitching movements at a height) and the incorrect use of the securing elements.

The "*Code of safe practice for cargo stowage and securing* (Res.OMI A. 714 (17)," contains recommendations on safe practices for stowing and securing cargo taken on board ships (not including solid or liquid cargo or bulk cargo or wood stored on deck) and in particular, for loads whose stowing and securing has led to difficulties in practice.

## 4. - Non-governmental regulations: the *Class Rules*

To offer a broad vision of the regulations established by classification companies regarding maritime construction and safety with respect to container ships, we should mention those included in the “*Rules for Building and Classing Steel Vessels*” (latest publication 2008), by the company ABS *American Bureau of Shipping*, in chapter 5.- “*Vessels Intended to Carry Containers (130m to 450m in length)*”. The company has also implemented regulations for container ships with lengths of less than 130m.

This chapter includes the technical requirements that specifically apply to container ships that are to be classified by the company. Their structure and content is as follows:

- Section 1.- Introduction.
- Section 2.- Considerations regarding the Design and General Requirements.
- Section 3.- Loading Criteria.
- Section 4.- Initial Scantling Criteria.
- Section 5.- Global Checking of the Resistance.
- Section 6.- Hull Structure over 0.4L from the midpoint of the ship's length.
- Section 7.- Cargo Protection.
- Appendix 1.- Guide for Checking Fatigue in Container Ships.
- Appendix 2.- Calculating the Critical Bending Stress.
- Appendix 3.- Definition of the Torque Properties of Hull Frames.

The following sections are worth highlighting from among those taken from Chapter 5.- “*Vessels Intended to Carry Containers (130m to 350m in length)*”:

### **Section 1.- Introduction:**

Ships that are designed and built in accordance with the requirements of this chapter shall have an estimate useful life of no less than 20 years. The cases in which the design aims to extend the estimated life of the ship beyond 20 years shall be indicated.

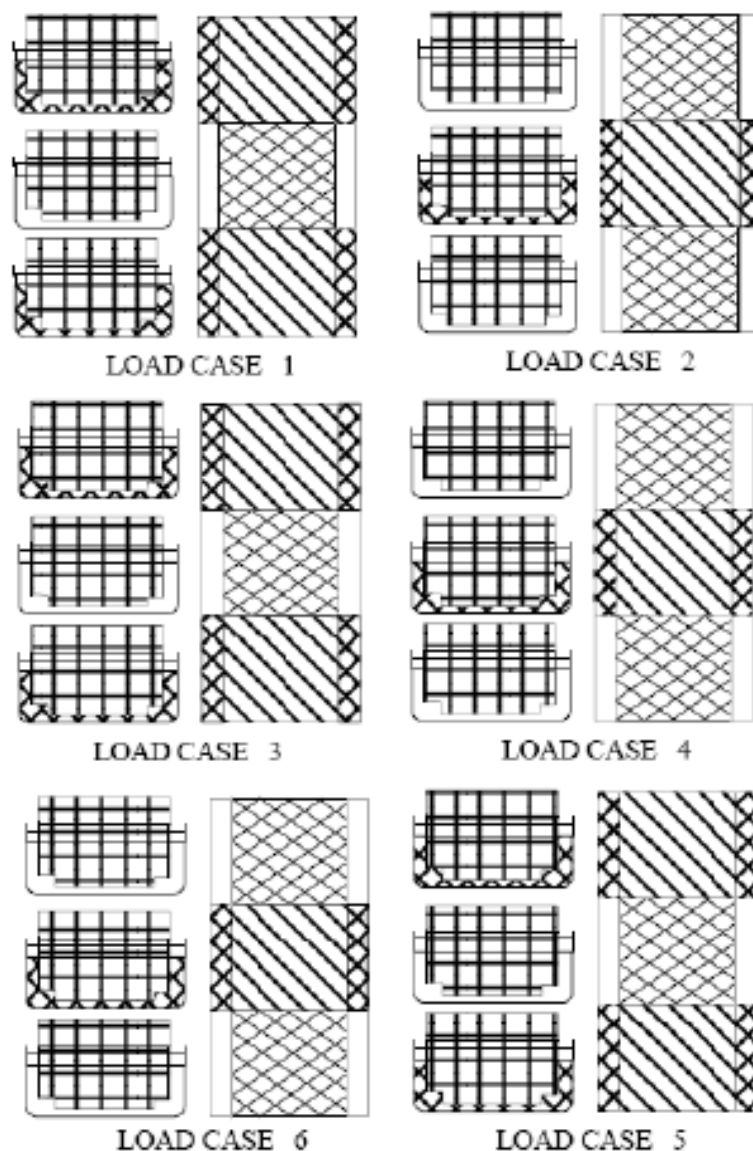
#### 5/1.3.1.- Length and Proportions:

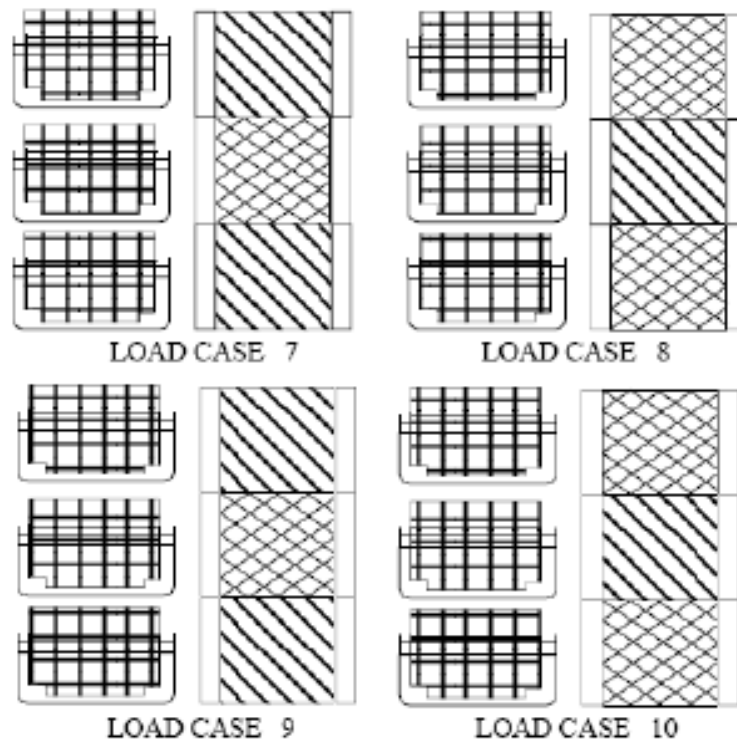
The requirements set forth in this chapter shall apply to container ships with lengths of between 130 and 450 metres (427-1476 ft).

### **Section 3.- Loading Criterion:**

#### 5/3.3.- Static Loads.

In calculating the local static load, the following loading assumptions shall be taken into consideration. They include different loading conditions for the ship, depending on the weight of the containers (light containers), the part of the ship on which they are loaded (bow, centre or stern) and the part of the ship that is ballasted (bow, centre or stern):





Light cargo: maximum of 7 tm/TEU.



Heavy cargo: maximum of 14 tm/TEU.



Ballast: specific gravity of 1,025

Graphs taken from chapter 5.- *“Vessels Intended to Carry Containers (130m to 450m in length)”* of the ABS *“Rules for Building and Classing Steel Vessels”*, Pg. 657, published in the website [www.eagle.org/rules.html](http://www.eagle.org/rules.html) (July 2008).

#### 5/3.5.5.2.- Loads due to the Containers:

In designing and evaluating the hull structure, the following loads shall be considered due to the loaded containers:

Static weight.

Dynamic forces due to the rolling and pitching effects of the vessel.

Internal forces due to acceleration.

In designing and evaluating the hull structure, all the containers shall be considered stowed as a block in the hold and on deck. All the containers in the hold shall be considered stowed and retained by the cell guides.

Loads due to stowage of the containers on deck shall apply to the hatch coaming or the corresponding supporting structures.

#### 5/3.7.3.- Local loads for Designing the Supporting Structures:

In determining the required scantling for the main supporting structures, such as stringers, floors, knee riders, etc., the normal loads induced by external pressures, ballast tanks and the load distribution in the worst condition shall be considered. In general, two cases shall be considered for determining the effects of dynamic load components:

Maximum internal load or pressure for a completely loaded hold, when the adjacent hold is empty and with minimum external pressure.

Hold that is empty with the adjacent holds in the direction of the bow fully loaded and with maximum external pressure.

#### 5/3.11.1.- Pressures due to Impact on the bottom of the ship:

For container ships, the loads due to impact on the bottom of the ship will be taken into account in situations of sailing under ballast in storms, to guarantee the plate resistance in the area located beyond  $0.4L$  (from the midpoint of the ship's length) to the bow, and the associated reinforcements.

#### 5/3.13.1.- Vibrations:

Apart from vibrations on the hull due to the impacts of the bottom and bow area, the vibrations produced by the propulsion system and the waves generated on the hull structure will be studied.



#### 5/3.13.3.- Loads due to Ice:

For ships that provide special services such as sailing in particularly cold areas, the effects of loads generated by ice on the resistance of the ship's structure shall be taken into consideration. The limits for loads due to ice shall be analysed by the designer.

#### 5/3.13.5.- Accidental Loads:

The effects of potential accidental loads on the reinforcement systems in the design of the main supporting elements at the side and bottom of the hull structure shall be taken into consideration.

For this purpose the nominal dimensions of the accidental loads shall be considered, taking them into account for cases of collision or running aground, as set forth in the "*Guide for Assessing Hull-Girder Residual Strength*" of the ABS, and the pressures in conditions of flooding of the watertight bulkheads.

### **Section 4.- Initial Scantling Criterion:**

#### 5/4.1.7.- Evaluation of Grouped Reinforcements:

If several elements in one group are considered to be the same, the module required for the section that they form shall be taken as the average for that required individually for each one.

The required section module for one group shall in no case be less than 90% of the greatest module required individually for any of the group reinforcements. Reinforcements of equal scantling laid out in the same way in a specific area may be considered as forming a group.

#### 5/4.11.- Double Bottom:

The ribbanding and longitudinal structural elements at the bottom of the ship shall be strong enough to support the loads when the ship is in dry dock.

#### 5/4.19.- Hatch Covers and Coaming:

The hatch coaming shall meet the following requirements:

The net thickness of the coaming plate shall be no less than 10mm (0.4 in.)

Horizontal reinforcements shall be placed on the coaming.

Vertical reinforcements shall be placed at intervals of no more than 3.0m (10 ft).

If the coaming has elements that retain the hatch covers and restrict their horizontal movement, the coaming and deck structure shall be strong enough to support the stress due to the retaining elements.

#### 5/4.25.1.- Watertight Transverse Bulkheads:

In operating conditions, with dynamic loads and relative displacement due to torque, the minimum dimensions of the horizontal and vertical structural elements of the watertight bulkheads may be determined using the global analysis resistance procedures by this document. In no case should the measurements be taken below 85% of the value obtained after calculating them, in operating conditions, applying the equations procedure that is set forth in the document.

### **Section 5.- Global checking of the Resistance:**

#### 5/5.1.5.- Stress Components:

The total stress of the plate in the hull stringers and floors reinforcements shall be divided into three categories:

Primary: primary stress is that generated as a result of bending. It may be determined by applying the beam theory, using the vertical and horizontal bending moments due to the swell.

Secondary: secondary stress is that generated as a result of bending of the reinforced panels between the longitudinal and transverse bulkheads due to local stress.

Tertiary: tertiary stress is that resulting from local bending stress in the plate between the reinforcements.

#### 5/5.3.1.- General considerations:

To prevent structural failure resulting from material fatigue, the stress calculated on the hull structure shall be within the limits set for each of the load combinations.

#### 5/5.7.- Fatigue:

Resistance of the welded joints to fatigue and details within area subjected to considerable stress shall be analysed, especially if high resistance steel is used.

#### 5/5.9.- Calculation of the Structural Response:

##### 5/5.9.3.- 3D Models of Finite Elements:

For the purpose of determining the load distribution on the structure, a simplified three-dimensional (3D) analysis is required using finite elements, representing the three cargo holds within 0.4L up to the midpoint of the ship's length.

#### 5/5.9.5.- 2D Models of Finite Elements:

To determine the distribution of the stress on the main supporting structures, especially at the intersections or two or more structural elements, a 2D model is required.

### **Section 6.- Hull Structure above 0.4L from the midpoint of the ship's length.**

#### 5/6.1.1.- General considerations:

The nominal corrosion values for structural elements located in spaces other than cargo holds shall be taken in keeping with those shown below, for establishing the design measurements:

- 1) 1.5 mm (0.06 in.) for the ship's side plate.
- 2) 1.0 mm (0.04 in.) for the ship's bottom plate.
- 3) 1.5 mm (0.06 in.) in spaces for tanks and double bottoms.
- 4) 1.0 mm (0.04 in.) in dry, covered spaces.

#### 5/6.1.3.- Structure in the Cargo Spaces:

The thickness of longitudinal structural elements in cargo spaces from 0.4L, from the midpoint of the ship's length shall be gradually reduced to 0.1L from the bow and stern, so that the section modules fulfils the requirements imposed by these rules.

### **Section 7.- Cargo Protection:**

5/7.3.1.- The cargo spaces for vessels of 2,000 GT or more shall be fitted with a permanent system for preventing fires caused by gas.

#### 5/7.5.- Refrigerated Containers:

When carrying separate refrigerated containers, the electrical load required by the containers through reserve generators shall be taken into account.

## **Appendix 1.- Guide for Checking Fatigue in Container Ships:**

### Section 1/7.3.1.- Components of Loads Induced by the Swell:

The fluctuating components that must be considered are those that are due to the effects of the swell. They are divided into the following groups:

Moments induced on longitudinal structural elements of the hull (vertical, horizontal and related to torque).

External hydrodynamic pressures.

Internal liquid load due to the movement of the vessel.

Similarly, this appendix also implements the aspects related to determining the force concentrations by means of analysis with finite elements.

## **Appendix 2.- Calculation of the Critical Bending Stress:**

### Section 2/1.- General considerations:

The critical bending stress of several different structural elements can be determined using the provisions of this appendix or recognised design practices. Critical bending stresses obtained through experimental data or analytical studies shall be considered, furnishing sufficient supporting information for their review.

### Section 2/ Reinforcements and Proportions:

To guarantee resistance to bending and the warping of the joints of structural elements and panels, the elements supporting the longitudinal plate panels shall comply with the requirements in respect of reinforcements and their proportions in areas with high stress concentrations.

Likewise, the mathematical calculation methods and equations used to obtain the axial compression stress of the longitudinal structural elements of the hull and deck are established, in addition to the bending stresses that affect them.

## **Appendix 3.- Definition of the Torque Properties of the Hull Frames:**

### Section 3/ 1.- General Considerations:

The torque properties of the hull frames shall be calculated using the beam theory. The appendix defines the torque properties of the hull frames used pursuant to the regulation. The torque properties of each design shall be calculated using computerised procedures.

---